



Figure 1

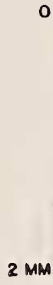


Figure 2

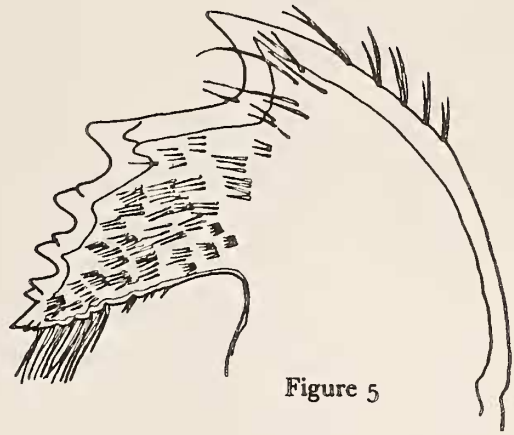


Figure 5



Figure 3



Figure 4

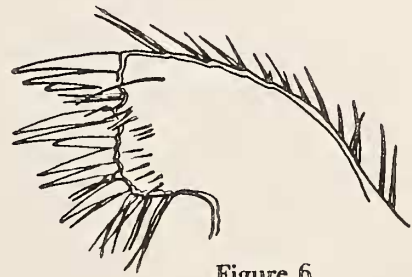


Figure 6



Figure 9

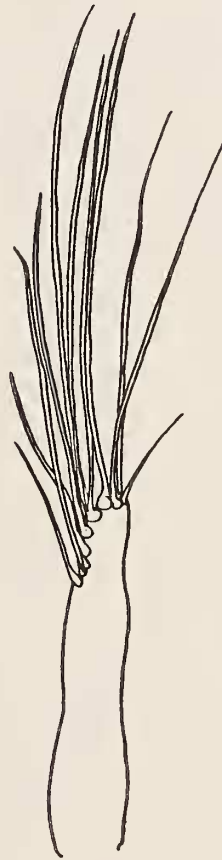


Figure 8

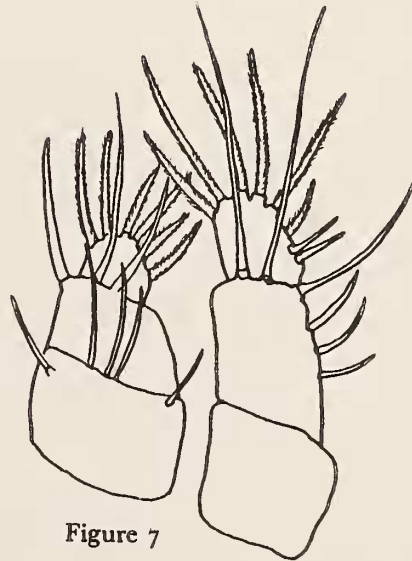
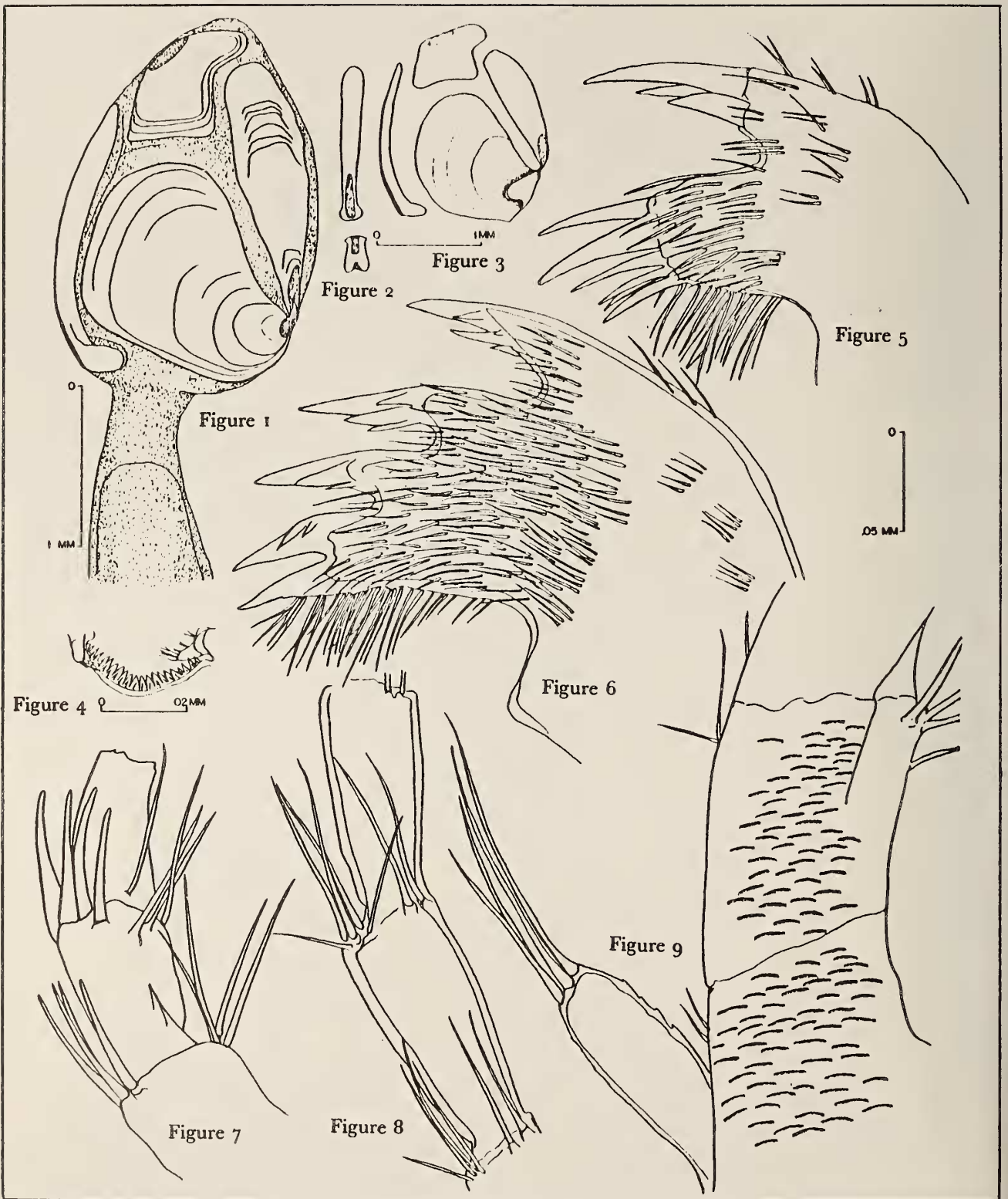


Figure 7



cimens, becoming less conspicuous with growth, essentially lost in mature forms except in tergal region. Surface studded with minute sharp spines which are transparent, never amber ("minute points or pseudo-cellular structures" in MacDonald's account), spines best seen along capitular margins or along folded edge of torn mantle (Plate 21, figures 3, 4).

Measurements taken from four specimens (in millimeters):

	Range	Mean
Capitulum		
Length:	1.72 - 2.25	2.08
Depth:	1.27 - 1.84	1.57
Width:	0.69 - 1.15	0.97
Peduncle		
Length:	0.92 - 1.95	1.32
Av. Diam.:	0.53 - 0.78	0.66
Total Length:	2.87 - 4.13	3.40*

\*Three millimeters in MacDonald's account.

Valves 5, much reduced. Scutum of 2 arms; occludent arm calcified, straight or a little convex, not overlapping tergum; basal arm reduced, chitinous rather than calcareous for most of its length ("rudimentary" according to MacDonald), traversing capitulum approximately one fourth the length of the capitulum above the capitulo-peduncular junction, pointing at or somewhat below the middle of the carina. Basi-scutal angle acute, ranging between  $50^\circ$  and  $76^\circ$  (mean  $64^\circ$ , from paired measurements of 18 specimens; approximately  $58^\circ$  in MacDonald's figure). Tergum variable in form; moon or saddle-shaped; occludent arm reduced, nearly lacking in some specimens. Carina not extending up between terga; forked basally; a small point extending below basi-carinal angle; basal arms of carinal fork for most part chitinous rather than calcareous, not overlapping basal arms of scuta.

Peduncle variable in length, depending on position on host and state of contraction; color pink, becoming maroon basally (color or tinting

comparable to color of gills and membranes of host); studded with minute closely spaced stout sharp spines.

Labrum bullate; bullate portion marked by fine widely spaced scales over general surface and a few short soft setae in front of crest area; crest supporting 15 to 21 rather closely-spaced small conical teeth (13 visible in MacDonald's figure, rest obscured?). Palps spatulate, supporting numerous long setae along upper margin and inner angle; lower margin and surface covered with small ctenoid scales. Mandible with 5 teeth, third, fourth, and fifth tooth bifid, second tooth occasionally bifid; fifth tooth, although smaller than fourth, not rudimentary, occasionally trifid; inferior angle cleft, forming 2, sometimes 3, hyaline spines; superior margin supporting several pairs of soft spines; inferior margin supporting numerous strong spines (Plate 21, figure 5). Inner maxilla with cutting edge nearly straight, divided into 2 portions by a small notch; portion above notch supporting 3 strong spines; notch with 2 spinules; portion below notch with 6 or 7 spines and a few spinules; superior margin with numerous pairs of soft spines equally spaced over at least half the entire length; inferior margin supporting 3 to 5 pairs of stiff spinules (Plate 21, figure 6). Outer maxilla rhomboid, corners rounded; superior margin supporting about 7 slender long curved spines and a few spinules; inner margin with numerous spinules.

Cirrus I with equal rami; rami one half length of rami of Cirrus II; outer ramus about three fourths the width of inner ramus; both rami clothed with dense soft setae; ultimate articles supporting 5 or 6 strong plumose spines and a few soft setae (Plate 21, figure 7). Cirri II through VI ctenopod, essentially equal in length and with equal or nearly equal rami; posterior margins of pedicles and some proximal articles supporting small distally directed scales. Inner curvature of intermediate articles of Cirrus VI supporting 7 pairs of setae, the number gradually becoming less in more distal articles; greater curvature supporting about 5 long setae in a clump at each articulation. Counts for the neotype are given below,

#### Explanation of Plate 22

*Octolasmis indubia* NEWMAN, spec. nov.

Figure 1: holotype; Figures 2 and 3: valves of a paratype; Figure 2: anterior and dorsal view of carina; Figure 3: disarticulated valves - lateral view of carina, interior view of tergum and scutum; Figures 4 through 9: trophi and appendages of holotype; Figure 4: labrum and palps; Figure 5: outer maxilla; Figure 6: mandible; Figure 7: intermediate articles of outer ramus of Cirrus IV; Figure 8: intermediate articles of outer ramus of Cirrus VI; Figure 9: caudal appendage and pedicle of Cirrus VI.

variations noted in other specimens being placed parenthetically:

Cirrus	I	II	III	IV	V	VI
Outer Ramus	6	10	9(10)	9	9	9
Inner Ramus	6(7)	10(9)	9	9	9	9

Caudal appendage unarticulate, nearly as long as pedicle of Cirrus VI, supporting apical tuft of about 10 long strong setae, the longest of which equals the length of the entire appendage (Plate 21, figure 8).

Penis moderately long, surface supporting a few scattered soft bristles occurring singly or in linear groups of 2, 3, or 4; tapering gradually for the first three quarters and then abruptly to a smaller diameter in distal quarter of length; basal surface clothed with closely spaced distally directed scales, central portion with smooth but irregular surface, distal third (except apical region) finely folded; apex without distinct terminal languet, supporting a few short spines followed by a transverse row of about 7 longer soft obliquely placed bristles of nearly equal length (Plate 21, figure 9).

### Discussion

The species *Octolasmis neptuni* (MacDonald, 1868), reinstated here, was originally described from the gills of *Neptunus pelagicus* (Linnaeus) from Moreton Bay, Queensland, Australia. It was placed in synonymy with *O. lowei* (Darwin, 1851) by Nilsson-Cantell (1927) while working on specimens from the gills of a xanthid crab, *Pseudocarcinus gigas* (Lamarck), from Tasmania. It is my opinion that although Nilsson-Cantell's form is *O. lowei* s.l., it is not *O. neptuni* as he supposed. It does not compare favorably with the material described here, which originated from the type locality and the type host and is clearly *O. neptuni* as originally described.

In addition to the Australian localities, MacDonald reports and describes a comparable barnacle from a swimming crab from Fiji. From the description and accompanying text, it appears that he is not at all convinced that the Fijian form is identical with those seen at Moreton Bay. Although one can only guess, it is my opinion that MacDonald's Fijian form is not *Octolasmis neptuni*. This opinion rests on MacDonald's own reluctance to confirm the identity and on the fact that the fifth tooth of the mandible is rudimentary and the rami of the

first cirri are grossly unequal. For these reasons the locality records for this species in the islands of the south west Pacific have been questioned.

### *Octolasmis (Octolasmis) neptuni hiroi*

NEWMAN, subsp. nov.

1937 *Octolasmis lowei* forma *neptuni* in part. Hiro: 426; fig. 13 E-H, fig. 15 A-C.

Locality: Seto Inland Sea, Japan, on gills and occasionally mouth parts of *Neptunus tuberculatus* Miers and on gills of *Charybdis japonica* (Milne-Edwards).

Holotype: U. S. N. M. Cat. No. 107'308; Hukuyama, Seto Inland Sea (34° 30' N. Lat.; 133° 22' E. Long.), on gills of *C. japonica*, kindly sent me by Dr. Huzio Utinomi.

Diagnosis: The present subspecies is described by Hiro (1937) from Japan, and it differs little from the typical form from Australia. The differences are considered diagnostic for the Japanese subspecies and are briefly described here: Color (in alcohol), opaque white; mature specimens with minute transparent closely spaced extremely low blunt spines clothing capitulum and peduncle. In the specimens on hand the basal arm of the scutum is for the most part calcareous rather than almost entirely chitinous as it is in the typical form. In any event, it ranges from needle-like to nearly absent, and this is normal for the species.

The following description is of an interesting species of *Octolasmis* from the mouth parts of a macrurous decapod crustacean from Hawaii. The valves, and armature of the mouth parts and cirri, are quite different from the aforementioned species. An understanding of these differences is crucial to an appreciation of the unique position occupied by this and related forms. For this reason, a consideration of their significance follows rather than precedes the general description.

### *Octolasmis (Octolasmis) indubia* NEWMAN, spec. nov.

(Plate 22)

Locality: Kaneohe Bay, Oahu, Hawaii (Coconut Island; approximately 21° 27' N. Lat.; 157° 47' W. Long.). Numerous specimens from the

mouth parts of a single specimen of *Scyllarides squamosus* (Milne-Edwards), the gills of which were infected with *Octolasmis lowei* (Darwin); collected by Stephen A. Wainwright.

Holotype: U. S. N. M. Cat. No. 107'310; paratypes: U. S. N. M. Cat. No. 107'311, 107'312.

Diagnosis: Capitulum ovoid, laterally flattened, of 5 valves separated from one another by a narrow border of mantle wall (Plate 22, figure 1). Carina narrow, extending up between terga, terminating basally in a bifurcate knob. Scutum of 2 arms connected by an uncalcified portion; occludent arm spatulate, extending into notch of tergum; basal arm broadly expanded, with internal broad flat platform. Border of scutum in line with occludent margin of capitulum below primordial valve, forming a broad curve with the basal margin. Labrum with numerous closely spaced large sharp teeth, palps relatively small (Plate 22, figure 4). Chaetotaxis of Cirrus IV acanthopod (Plate 22, figure 7). Mandible with 4 sharp teeth, each tooth with strong basal spines; inferior angle developed as a sharp tooth, often as large as the fourth tooth (Plate 22, figure 6). Inner maxilla with 3 strong spines above and approximately 6 spines below the deep notch, second spine in lower group strongest (Plate 22, figure 5).

Description: Five valves, appearing as 7 due to incomplete calcification of scuta above rostral angle (Plate 22, figures 1-3). Carina narrow, extending up between terga, terminating proximally in a bifurcate knob, calcification not extending below primordial valve. Tergum broad, rounded, tending to form 3 angles; carinal angle projecting between carina and basal arm of scutum; median angle extending over occludent arm of scutum; median and occludent angles forming notch receiving distal portion of occludent arm of scutum. In young specimens, terga somewhat rectangular, although indentation receiving occludent arm of scutum already developed. With growth, portion between carinal and median angles of tergum broadens and the scutal indentation becomes reduced. Occludent arm of scutum spatulate, connected to basal arm by a yellowish ligament overlying primordial valve. About three fourths of the primordial valve extends onto the occludent arm of the scutum in large individuals. Basal arm of scutum broadly expanded, rounded; interior portion, near rostral angle, thickened and elevated as a broad flat platform. Platforms of scuta are fused, rendering basal segments rigid, preventing lateral compression of the animal. (Valves can be readily separated by corrosion of cementing substance with five percent sodium hypochlorite.) Ligament al-

lows movement of the occludent arm and permits closure of the aperture. The nearly complete armored condition seen in mature specimens is attained by slow ontogenetic increments, during which the area occupied by the valves becomes greater and greater. This process is quite unusual and its postulated significance is taken up in the discussion below.

Peduncle: Smooth, without chitinous spines, knobs, beads, or calcareous inclusions; length apparently dependent upon position of barnacle on host.

Measurements for four individuals (in millimeters):

#### Capitulum

Height	Width	Depth
1.2	0.4	0.9
1.4	0.6	1.0
1.8	0.8	1.3
2.0	0.8	1.4

#### Peduncle

Length	Average Diameter
3.5	0.35
2.5	0.3
3.5	0.5
3.5	0.5

Labrum bullate, crest supporting approximately 21 strong sharp teeth. Palps oblong, sparsely setose along the superior margin and inner angles; situated well toward lateral margins of labrum (Plate 22, figure 4). Mandible with 5 sharp teeth not including inferior angle; first, second, third, and fourth teeth supporting 2 to 4 strong spines at their bases (not pectinate in the ordinary sense); inferior angle forming a sharp tooth which may be equal to or slightly less well developed than the fourth tooth (Plate 22, figure 6). Inner maxilla with 3 strong spines above and 7 strong spines below deep notch, second spine in the lower group the strongest; 3 pairs of setae along upper margin appear to be a constant characteristic (Plate 22, figure 5). Outer maxilla broadly rounded, clothed sparsely with short bristles and long slender spines or setae along the superior and inner margins.

Cirri relatively short and stout. Cirrus I with unequal, Cirrus II with subequal, and Cirri III through VI with equal rami. Pedicles of Cirrus I originate at some distance forward of Cirrus II. Outer ramus of Cirrus I about two-thirds as long and two-thirds as wide as inner

ramus; clothed with numerous long relatively soft setae; terminal article supporting tuft of about 3 stout spines; inner ramus clothed with numerous stout setae. Several proximal articles of rami of Cirrus I with indistinct or fused sutures. Cirrus IV with articulations of fourth and fifth articles of rami supporting about 4 stout claw-like spines on the greater curvature and 3 to 4 slender long spines on the lesser curvature. Fourth and fifth articles of Cirrus VI supporting approximately 4 slender spines on greater and 2 or 3 slender spines on lesser curvature at the articulations (cf. Plate 22, figure 8 — a canthopod; figure 9 — lasiopod). Pedicles of all cirri, except the first, clothed with minute ctenoid elevations or scales (Plate 22, figure 9).

Counts of articles of the rami are given below for two speci

with minute ctenoid elevations or scales (Plate 22, figure 9).

Counts of articles of the rami are given below for two specimens. Although Cirrus I is 6-6, three segments in each are fused. The first set is for the holotype.

Cirrus	I	II	III	IV	V	VI
1. Outer Ramus	6	8	7	8	7	7
Inner Ramus	6	7	8	8	7	6
2. Outer Ramus	6	8	8	8	8	8
Inner Ramus	6	6	9	8	8	8

Caudal appendage as long or slightly longer than the first article of pedicle of the Cirrus VI; margins roughened by scales; apex supporting a tuft of 4 to 6 long slender spines (Plate 22, figure 9). Penis smooth, tapering gradually through its length; clothed sparsely with minute setae not symmetrically arranged; terminating abruptly with a tuft of terminal sensory hairs, apical or just below a rounded terminal languet.

### Discussion

The species described here has been assigned to the subgenus *Octolasmis* because the valves and their primordia are most comparable to those of other members of this group; that is, the terga are notched to receive the distal ends of the occludent arms of the scuta, and the primordial valves of the scuta lie in a line along the occludent margin of the capitulum. The latter character is the most undisputed diagnostic feature for the subgenus, and

its form clearly separates this species from species of *Temnaspis*, which is currently somewhat enigmatic (Broch, 1932; and 1947; Nilsson-Cantell, 1934; Stubbings, 1936).

The following species of the Poecilasmidae are known to me from Hawaii:

1. *Trilasmis* (*Temnaspis*) *fissum hawaiiense* (Pilsbry, 1928)  
1899 *Trilasmis fissum* Weltner
2. *Trilasmis* (*Trilasmis*) *eburneum* Hinds, 1844
3. *Trilasmis* (*Poecilasma*) *kaempferi* (Darwin, 1851)
4. *Octolasmis* (*Octolasmis*) *lowei* (Darwin, 1851)
5. *Octolasmis* (*Dichelaspis*) *hawaiiense* (Pilsbry, 1907)
6. *Megalasma* (*Megalasma*) *minus* Annandale, 1906  
1907 *Poecilasma bellum* Pilsbry

Of the Hawaiian forms, the present species is most similar to *Trilasmis* (*Temnaspis*) *fissum hawaiiense*. These two barnacles are comparable in size and habitat but are basically different in the development of the primordial valve of the scutum and the degree of armament of the capitulum. *Trilasmis* (*T.*) *fissum hawaiiense* is more fully covered by its valves, the scutal umbo is "rotated" basally, the distal portions of the scutal arms are acute rather than rounded, the tergum is considerably more reduced and is not notched to receive the occludent arm of the scutum, and the carina terminates in an "obtuse tooth and a distinct heel" rather than a bifurcate knob. Internally, the scutal platform is basal, corresponding to the rotation of the umbo, rather than being situated along the occludent margin. The mouth trophi are similar in both species, however, the fourth rather than the second spine below the notch of the inner maxilla is strongest in Pilsbry's form, the mandible has but 4 teeth, including the inferior angle, and the teeth are simple, lacking spines or pectinations. The chaetotaxis and mouth trophi of the new species appear quite similar to those described for *Octolasmis clavula* Hiro (1936) from Japanese waters, especially in regard to the details of the mandible. However, there are so many differences in the form of the valves that further comparison seems unnecessary. A comparison with *O. tridens* (Aurivillius, 1894) and its Caribbean allies (forms all having ctenopod cirri) seems superfluous. At this time I see no close affinities of the new species with any form known to me. The barnacle clearly shares characters with members of the genera *Trilasmis*, *Temnaspis* (if considered valid), and *Octolasmis*. As Broch (1931) has pointed out, the group is in need of revision.

The nearly fully armored condition seen in mature specimens of this species is achieved

through slow ontogenetic increments in the valves, particularly in the basal arm of the scutum, at a rate greater than the rate of increase in the size of the capitulum. By this sort of differential development, partially armored juveniles become fully armored somewhat later in life than do related free-living species in which juveniles are essentially as fully armored as adults. The same process is seen to occur in *Octolasmis tridens* (Aurivillius), (Nilsson-Cantell, 1934), and in *O. cor* (Aurivillius), (Newman, 1960b). This process suggests that species in this family with the scutum split into two parts have descended from forms in which the valves were much reduced, the split-valve being a product of rearmament. This suggestion is believed to be quite plausible for it not only explains their somewhat aberrant form, but it also explains the vestige of a scutal suture seen in such species as *Trilasmis eburneum* Hinds and occasionally in *T. crassum* sensu Darwin (1851). These two species have apparently completed the rearmament process, the vestigial, fully-fused, non-functional suture testifying to a split-valve ancestry, being acquired through relatively unarmored forms living in protected environments.

This argument is contrary to the concept of the prototype of split-valve forms in which Pilsbry (1911) envisions a fully armored ancestral type with a split-valve already developed, becoming reduced in protected environments. The same argument is the reverse of that of Broch (1947), which is essentially Pilsbry's concept in more detail, without additional evidence. What Pilsbry and Broch fail to take into consideration is the functional aspect of the split-valve; that is, what purpose does it serve the barnacle, especially when the occludent arm is immovably fused to the basal arm? They also fail to consider what possible path selection might take to achieve such an unusual structural arrangement.

In fully armored species, without a split-valve, the scuta are hinged to one another as they are in nearly naked species of *Octolasmis*. In this way the valves can be opened and closed, and when closed, being fully approximate at their edges, they prevent crushing of the soft animal within. Forms with greatly reduced valves are relatively easy to crush, but they generally survive in environments where crushing is not likely to occur. If rearmament were gradually selected for, in response to more exposed conditions, the barnacle would still be subject to crushing until the valves be-

came fully approximate. In such partially armored forms, this problem is overcome by a fusion of the hinge area of the basal scutal arms, which, being the strongest and overlying the body of the animal when withdrawn, offer fair protection. However, this necessitates having the occludent arms, each connected to a basal arm by an uncalcified ligament, free to be drawn together by the scutal adductor muscle, closing the aperture. In this way, partially armored species are protected against crushing, yet retain the facility of closing. In exploiting more exposed environments, fuller armament being selected for, the valves would become fully approximate. Fusion of the basal scutal arms is no longer a requirement but actually a disadvantage, for the occludent arms must remain free of the basal arms in order to continue to close the aperture. This arrangement sacrifices a considerable degree of rigidity. In overcoming this final complication in rearmament, the fusion platforms could become transformed into a hinge, with the simultaneous fusion of the occludent arm to the basal arm of the scutum, leaving the vestigial suture mentioned above. Indeed, the peculiar hinge-like platforms of *Trilasmis fissum* (Darwin) and the peculiar hinge of *T. eburneum* Hinds are more readily understood as being derived in this way than from the ordinary hinge of more remote fully armored ancestral forms.

Following this explanation for the origin of the split scutal valve, it appears most likely that split-valve forms have descended from relatively naked ancestors inhabiting the gill chambers of decapod Crustacea (Plate 23). This is not as unlikely as it may at first appear, for it is a fact that relatively unarmored species which inhabit gills are often found occurring around the exhalant area of gill chambers and along the basal portions of the last maxillipeds of the host (Annandale, 1909). In this position they are at a disadvantage as regards mechanical injury, but they conceivably may be rewarded by fragments of food drifting away from the food being fed upon by the host. To this end a ctenopod feeding mechanism would be satisfactory, for barnacles could carry on normal setose feeding when not receiving food escaping the host. If the protection afforded by fuller armor were attained in forms tending to settle near the mouth field, there would be a better chance of survival. Thus, they could occupy positions further out on the mouth parts, closer to the new source of food. If the rather delicate feeding mechanism were gradually replaced with stouter clawed append-

ages, the barnacle might be able to capture larger particles of food or even rasp directly at the food being manipulated by the host. It is a fact that most split-valve forms occur on the mouth parts, primarily the maxillipeds of macrurous forms, and it is a fact that where the ontogeny of these forms is known, the split-valve is seen to be acquired through slow ontogenetic increments and differential growth. It may be simply a coincidence that most species in this position also have very peculiar, strong, stout clawed cirri and unusually spiny mouth parts which appear poorly adapted to setose feeding, but I prefer to suggest that these structures are correlated with the unique habitat in which the barnacle, having descended from forms inhabiting gill chambers, has moved forward into the mouth field, enabling it to share the food of the host.

That such species are the descendants of more naked ancestors and have come to occupy such an unusual niche by an indirect route through the gill chambers of the host is suggested not only because it would explain the split-valve as a result of rearmament, but also because a more gradual transitional process could hardly be imagined in achieving such a remarkable and precarious position on the host and in attaining the highly modified feeding mechanism correlated with it.

### Acknowledgment

Specimens of *Octolasmis* (*Octolasmis*), *Trilasmis* (*Trilasmis*), *T.* (*Poecilasma*), and *Megalasma* (*Megalasma*) studied in conjunction with this paper were obtained from a number of individuals to whom I am deeply indebted. The specimens originated from widely separated localities, and together they allow one to gain a fuller concept of the family than could otherwise be obtained. I am grateful to Dr. Thomas E. Bowman for the loan of specimens

from the Caribbean, to Dr. Fenner A. Chace, Jr., for the loan of specimens from the Society Islands, to Dr. Cadet Hand for specimens from New Zealand and Australia, to Dr. Arthur G. Humes for specimens from the Caribbean, East Africa, and New Guinea, to Arnold Ross for specimens from the Caribbean, to Dr. H. G. Stubbings for specimens from West Africa, to Stephen A. Wainwright for specimens from Hawaii, to Dr. Huzio Utinomi for specimens from the Seto Inland Sea, and to Victor A. Zullo for specimens from Shoal Guyot, South East Pacific. I would also like to thank Dr. Hand for his reading and criticism of the manuscript.

It is currently my wish to revise the family Poecilasmatae and I solicit specimens from any quarter of the world for this purpose.

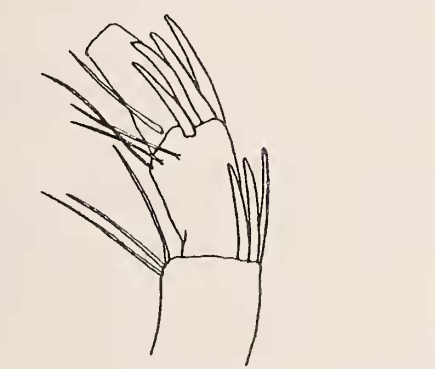
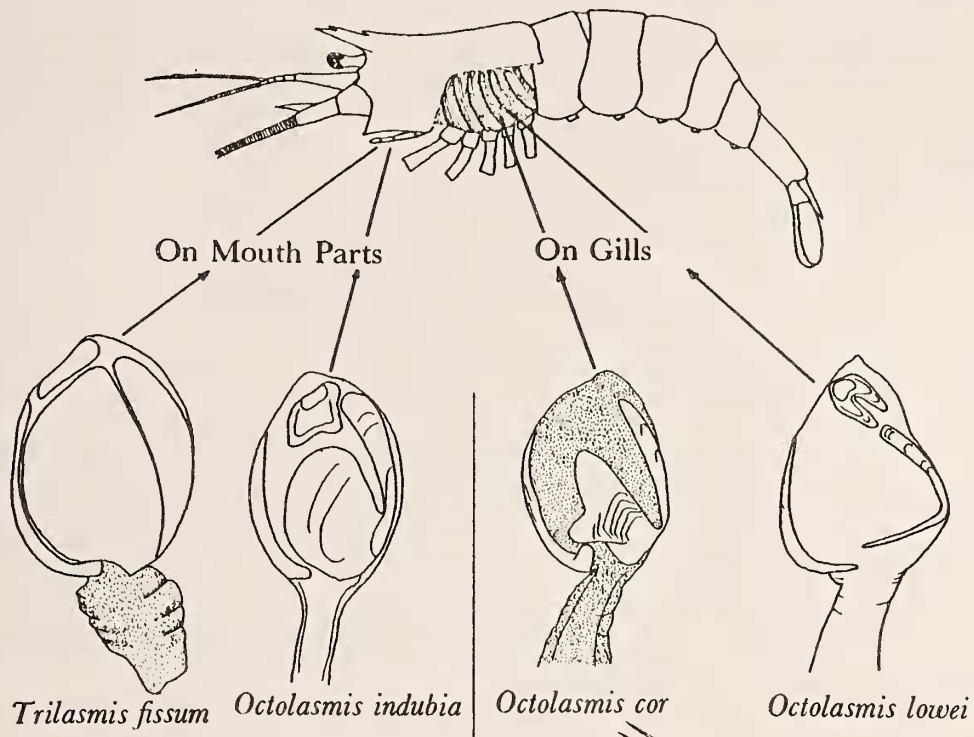
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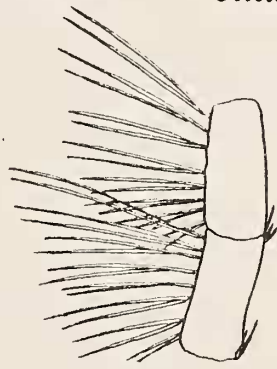
### Explanation of Plate 23

Schematic drawing indicating certain types of barnacles associated with gills and mouth parts of decapod crustacea. From right to left: *Octolasmis lowei* (DARWIN), usually on "soft" gills of macrurans, and *Octolasmis cor* (AURIVILLIUS), usually on the "hard" gilled brachyuran, *Scylla serrata* (FORSKÅL); *Octolasmis indubia* NEWMAN, spec. nov. and *Trilasmis fissum* (DARWIN), both usually on last maxillipeds of maerura. While acanthopod types are quite location-specific, lasiopod and etenopod types are not, their degree of armament apparently determining where they will survive. The lasiopod type (PILSBRY, 1911) is an intermediate condition between ctenopod and acanthopod types. Split-valve forms can be acanthopod, lasiopod or etenopod, while unarmored forms are always etenopod as are armored forms that do not have a split-valve ancestry.





Acanthopod Types



Ctenopod Types